



# Distributed Cognition: The Basis for Coordinated Action in Dynamic Environments

分布式认知：动态环境中协调行动的基础

露易丝.康福特

匹兹堡大学

Louise K.Comfort

University of Pittsburgh

Pittsburgh, PA 15260

[comfort@gspia.pitt.edu](mailto:comfort@gspia.pitt.edu)

# Distributed Cognition

## 分布式认知

- Represents a systematic effort to structure learning processes in complex environments
- 代表复杂环境中结构学习过程的系统努力
- Acknowledges that response to extreme events requires timely coordination of many actors
- 承认对极端事件的反应需要多方适时协调
- Facilitates creation of a common profile of risk
- 促进危机公用信息的构建
- Supports adaptive performance essential to achieve collective action for communities
- 支持对实现社区集体行动至关重要的适应性执行

# Distributed Cognition (cont'd)

## 分布式认知(续)

- Structures information processes to aid comprehension
- 使信息处理过程结构化以便于理解
- Extends beyond individuals to organizations, instruments used in calculating information for action
- 由个人扩展到组织，以及行动信息计算所用的信息
- Depends on design of technical instruments & organizational processes
- 依赖于技术手段和组织流程设计
- Recognizes that no single individual or agency can manage complex events
- 认识到没有哪个个人或机构可以单独管理复杂事件

# Need for situational assessment 形势评估的必要性

- What conditions facilitate, inhibit distributed cognition?  
何种情形促进、阻碍分布式认知？
- What technical instruments, organizational processes measure change?  
何种技术手段、组织过程可以衡量变化？
- How can socio-technical systems be designed to support effective decision making?  
如何设计社会技术系统以支持有效决策？

# Theoretical perspectives on decision making in complexity

## 复杂环境中决策的理论视角

- Distributed cognition: E.Hutchins, 1995
- 分布式认知, E.哈钦斯, 1995
- Sense making: Karl Weick, 1995
- 找到感觉: 卡尔.维克, 1995
- Network analysis: Andrews & Knoke, 2005
- 网络分析: 安德鲁, 诺克, 2005
- Computational simulation of decision processes under changing conditions: Carley, 2002
- 变革情形下决策过程计算机仿真: 卡利, 2002

# Disaster Operations

## 灾难运作

- Represent creation of a ‘cognitive system’ that captures experience of many actors
- 创建一个获取多方经验的“认知系统”
- System performs a function that enables the achievement of complex tasks
- 系统履行职能使复杂任务得以完成
- Validity demonstrated by its performance in many contexts by many different people
- 不同环境不同人群条件下执行的有效性

# Disaster Operations (cont'd)

## 灾难运作(续)

- Creates a 'computational ecology' as expertise in performance develops, spreads
- 在执行的发展和延伸过程中创建一个“计算机的生态系统”作为专家意见库
- Tools constitute a network of interdependent sources of information to support decisions
- 将相互依赖的信息源组成一个网络以支持决策

# Implementation

## 执行

- Involves computation of strategies for action
- 估算行动战略所涉及的各个方面
- Computation: representation of information regarding current state across many media
- 估算：将有关当前状态的信息提供给各个媒体
- Maps, operations logs are directly observable to other actors in system
- 系统中其他行动者可以直接看到地图和操作日志



# Implementation (cont'd)

## 执行（续）

- Actions that produce information shape cognitive capacity of system by...
- 通过.....行动过程，其产生的信息形成认知能力
- Creating new mental structures to store, access information about task, performance
- 创建一个新的脑力结构用以储存、获取有关任务执行的信息

# Comparative Analysis of Response Systems

## for Hurricanes Katrina and Rita

### 卡特里娜和丽塔飓风反应系统的比较分析

- Hurricane Katrina 卡特里娜飓风:
  - Landfall on August 29, 6:10 am, east of New Orleans; Category 4 winds; severe consequences to community
  - 2005年8月29日上午6:10 奥尔良东部登陆, 4类风; 社区被严重破坏
- Hurricane Rita 丽塔飓风:
  - Landfall on September 24, 2005 near Texas/ Louisiana border; Category 3 storm; timely evacuation
  - 2005年9月24日在靠近德克萨斯和路易斯安娜边界处登陆, 3类风暴; 及时疏散

# Comparative Analysis of Response Systems for Hurricanes Katrina and Rita (Cont'd)

## 卡特里娜和丽塔飓风反应系统的比较分析 (续)

- Same federal laws; different states; different local policies & practice
- 同样的联邦法律；不同的州；不同的当地政策与实践
- Evidence of policy learning?
- 政策学习的一个证明？

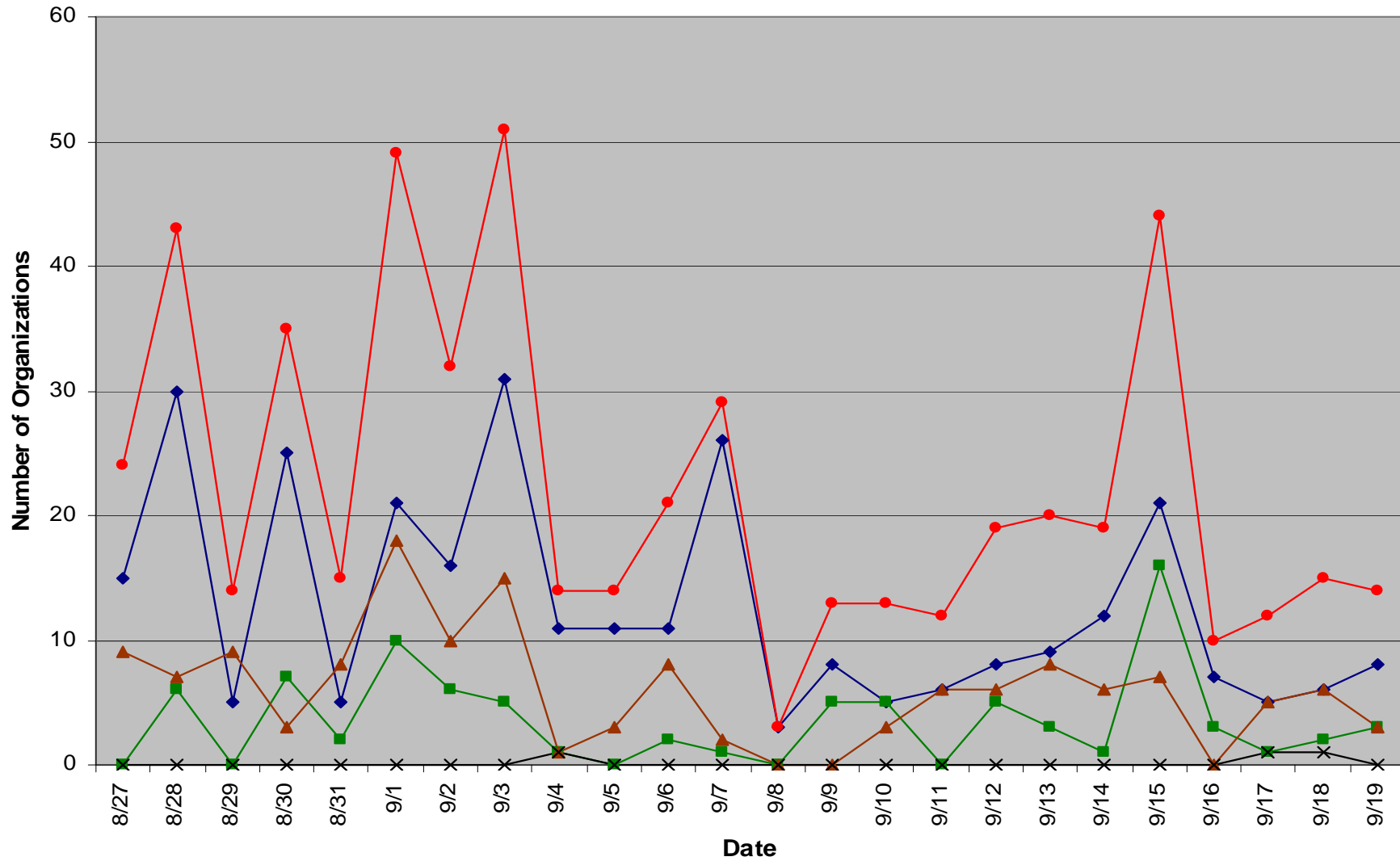
**Table 1**

**Frequency Distribution of Organizations Identified  
in the Full Hurricane Katrina Response System\***  
卡特里娜飓风全面反应系统中参与组织的频数分布

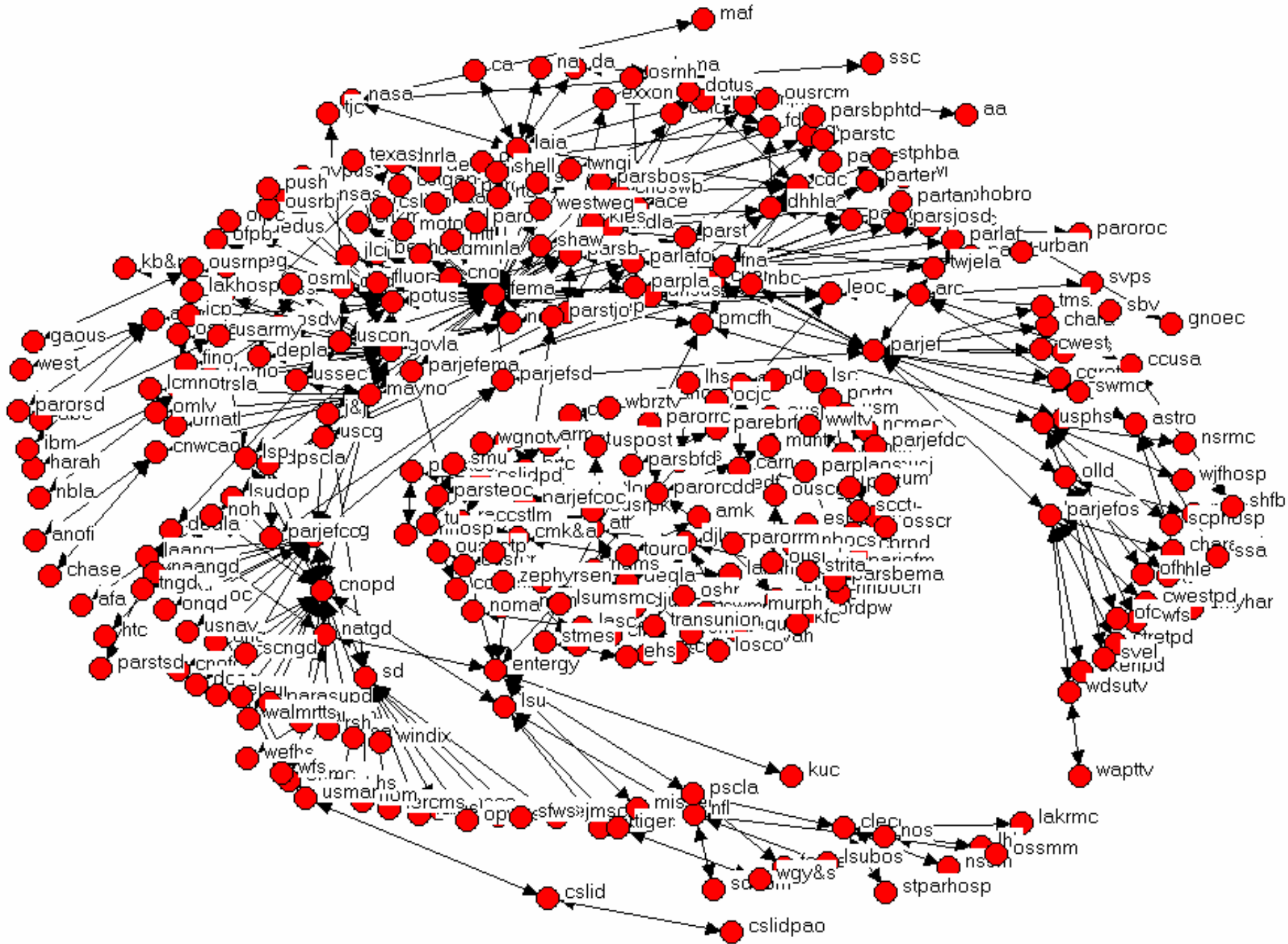
	Source of Funding									
	Public		Private		Non-Profit		Special-Interest		Totals	
Level of Jurisdiction	N	%	N	%	N	%	N	%	N	%
<b>International</b>	11	2.1%	3	0.6%	5	0.9%	0	0.0%	<b>19</b>	3.6%
<b>National</b>	0	0.0%	24	4.5%	75	14.1%	1	0.2%	<b>100</b>	18.8%
<b>Federal</b>	67	12.6%	0	0.0%	0	0.0%	0	0.0%	<b>67</b>	12.6%
<b>Regional</b>	1	0.2%	7	1.3%	26	4.9%	0	0.0%	<b>34</b>	6.4%
<b>State</b>	79	14.8%	7	1.3%	4	0.8%	2	0.4%	<b>92</b>	17.3%
<b>Sub-Regional</b>	11	2.1%	12	2.3%	9	1.7%	0	0.0%	<b>32</b>	6.0%
<b>Parish/County</b>	55	10.3%	3	0.6%	1	0.2%	0	0.0%	<b>59</b>	11.1%
<b>District</b>	27	5.1%	2	0.4%	0	0.0%	0	0.0%	<b>29</b>	5.4%
<b>City</b>	53	9.9%	27	5.1%	21	3.9%	0	0.0%	<b>101</b>	18.9%
<b>Totals</b>	<b>304</b>	<b>57.0%</b>	<b>85</b>	<b>15.9%</b>	<b>141</b>	<b>26.5%</b>	<b>3</b>	<b>0.6%</b>	<b>533</b>	<b>100.0%</b>

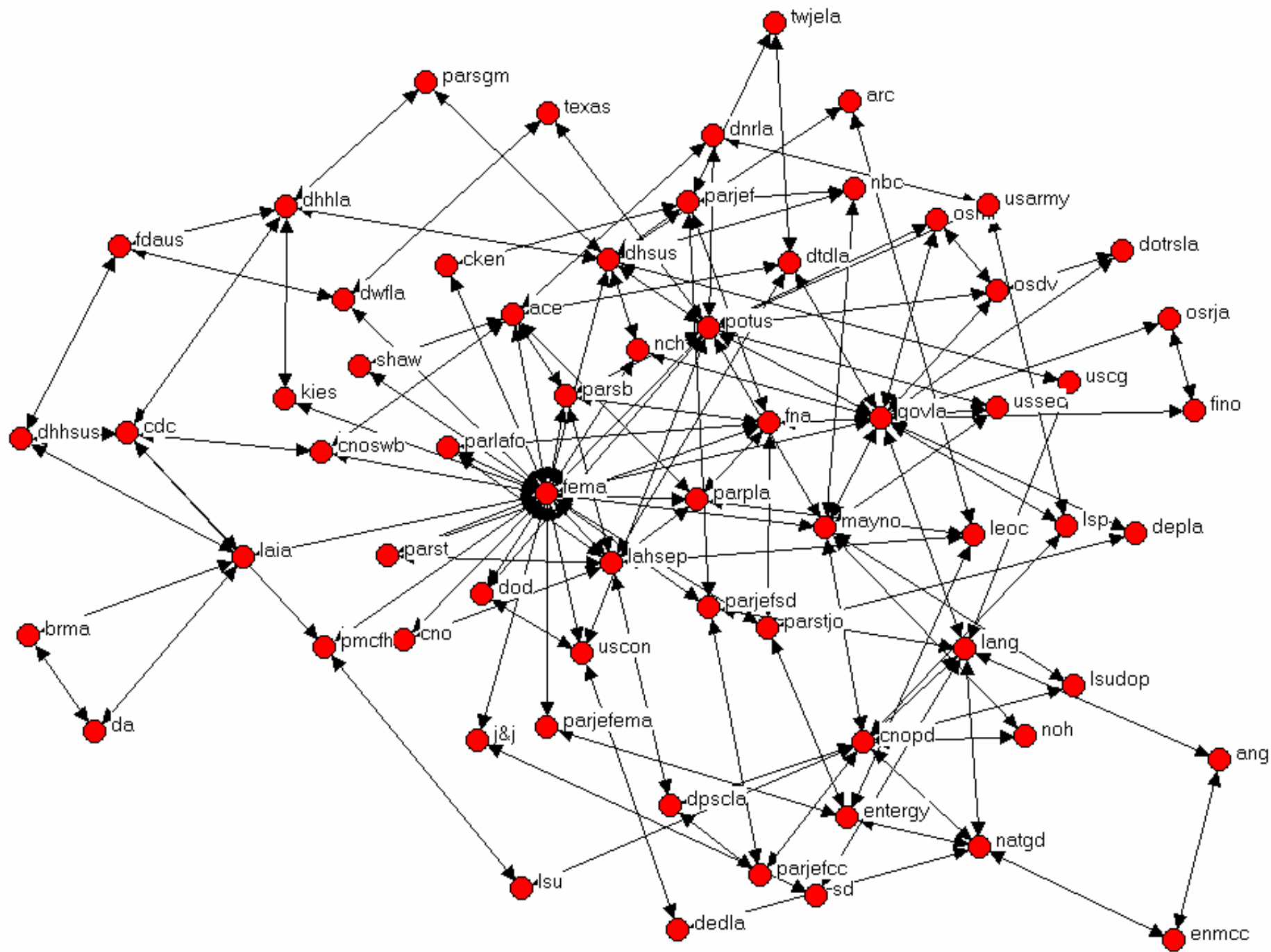
Source: *Times Picayune*, New Orleans, LA, August 27, 2005 – September 19, 2005.

## Entry of Organizations into the Full Response System by Date and Source of Funding



◆ Public   
 ■ Non-Profit   
 ▲ Private   
 × Special Interest   
 ● Total





**Table 2**  
**Descriptive Statistics, Degree Centrality, Interacting Organizations,**  
**Hurricane Katrina**

	<b>1</b>	<b>2</b>	<b>3</b>
	<b>Degree</b>	<b>NrmDegree</b>	<b>Share</b>
1 Mean	2.271	0.719	0.003
2 Std Dev	3.604	.140	0.005
3 Sum	720.00	227.848	1.000
4 Variance	12.986	1.301	0.000
5 SSQ	5752.00	576.029	0.011
6 MCSSQ	4116.67	412.261	0.008
7 Euc Norm	75.842	24.001	0.105
8 Minimum	1.000	0.316	0.001
9 Maximum	4.000	13.924	0.061

Network Centralization = 13.29%

Heterogeneity = 1.11%. Normalized = 0.80%;

MCSSQ = Mean Centered Sum of Squares



## Frequency Distribution of Organizations Identified

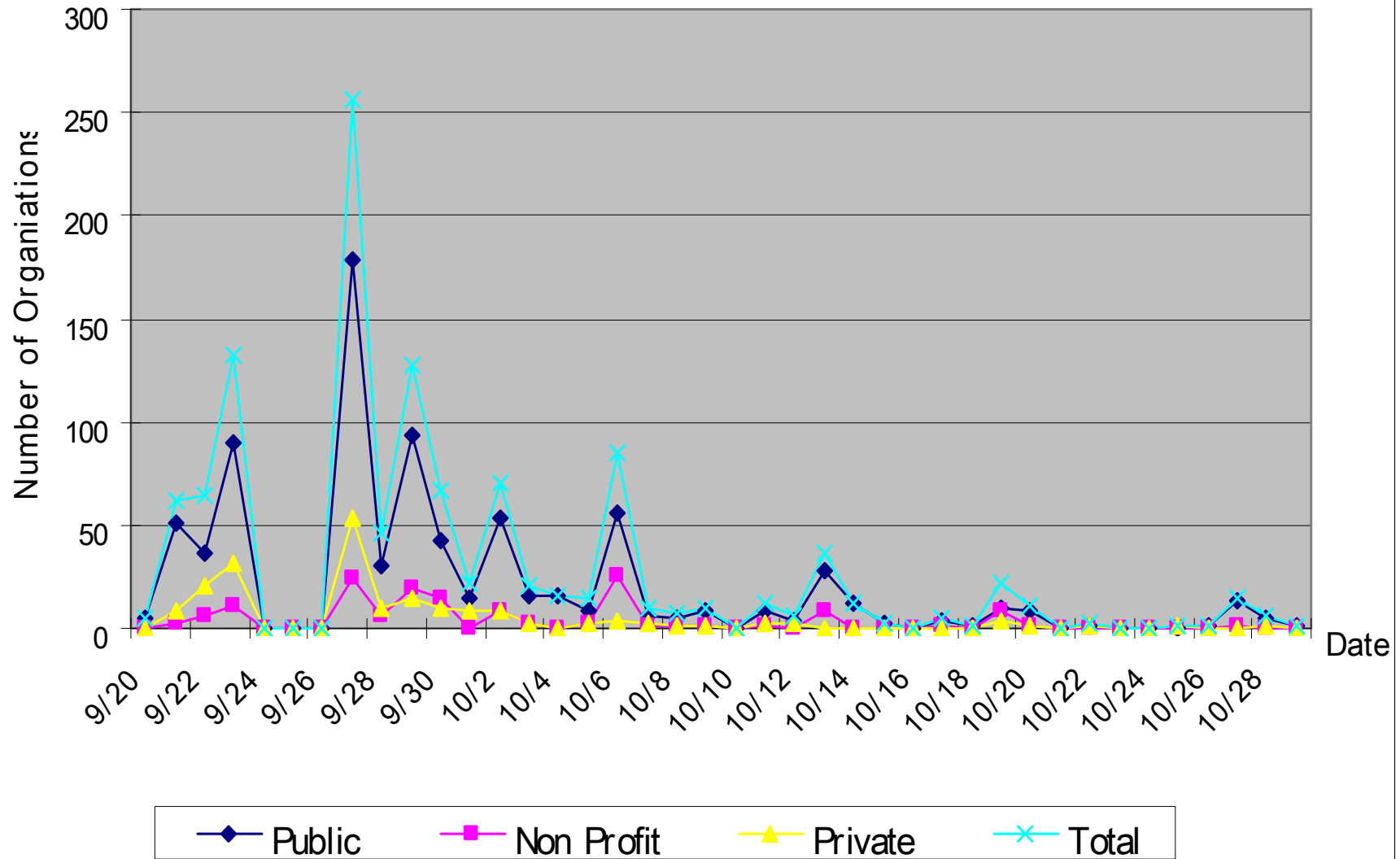
### in the Full Hurricane Rita Response System\*

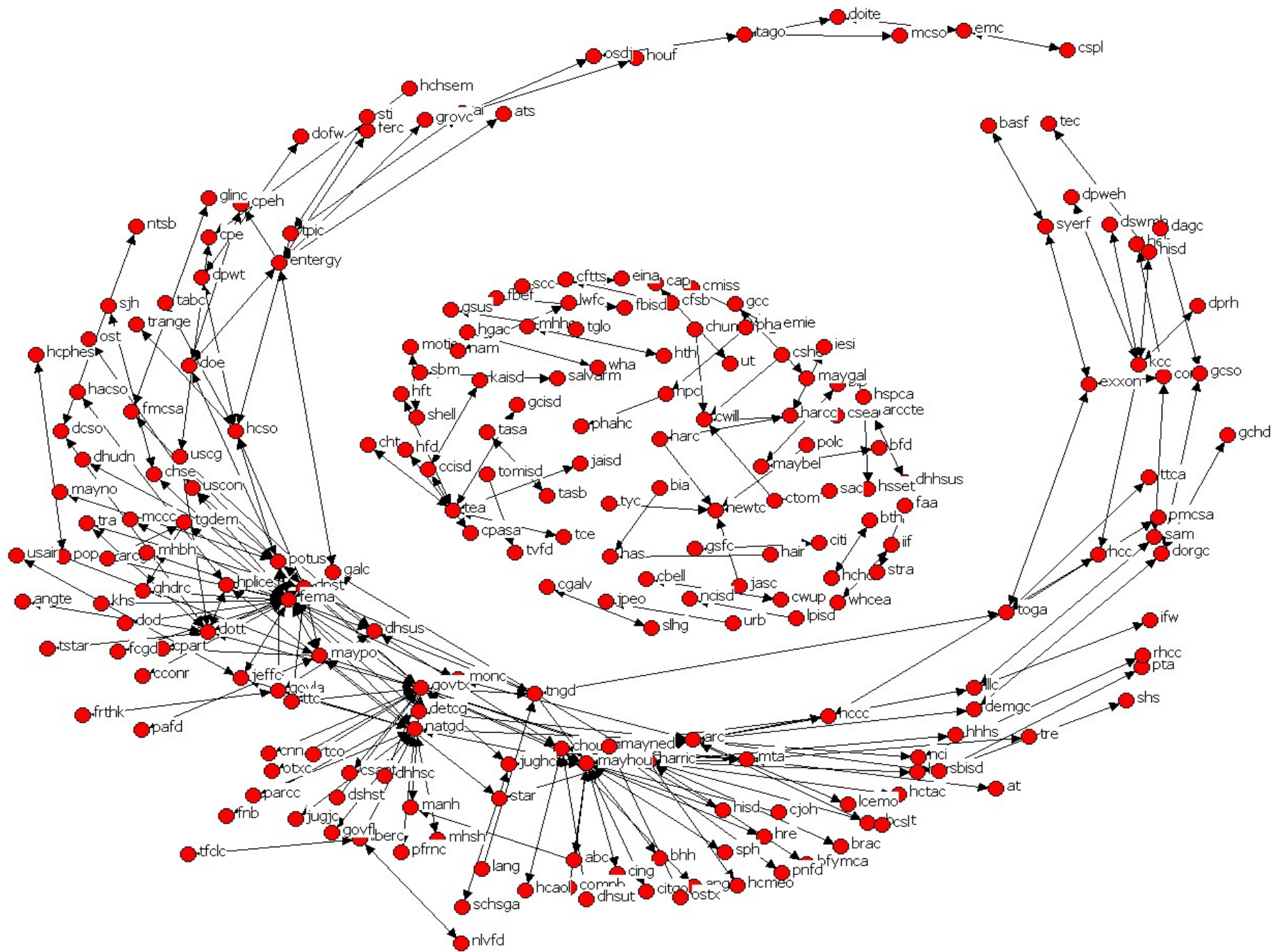
飓风全面反应系统中参与组织的频数分布

	Source of Funding							
	Public		Private		Non-Profit		Totals	
Level of Jurisdiction	N	%	N	%	N	%	N	%
<b>International</b>	3	42.9%	3	42.9%	1	14.3%	<b>7</b>	1.3%
<b>National</b>	3	4.2%	51	70.8%	18	25.0%	<b>72</b>	13.4%
<b>Federal</b>	50	100.0%	0	0.0%	0	0.0%	<b>50</b>	9.3%
<b>Regional</b>	7	15.9%	26	59.1%	11	25.0%	<b>44</b>	8.2%
<b>State</b>	65	75.6%	1	1.2%	20	23.3%	<b>86</b>	16.0%
<b>Sub-Regional</b>	7	31.8%	9	40.9%	6	27.3%	<b>22</b>	4.1%
<b>Parish/County</b>	79	88.8%	6	6.7%	4	4.5%	<b>89</b>	16.6%
<b>District</b>	25	89.3%	0	0.0%	3	10.7%	<b>28</b>	5.2%
<b>City</b>	88	63.3%	14	10.1%	37	26.6%	<b>139</b>	25.9%
<b>Totals</b>	<b>327</b>	60.9%	<b>110</b>	20.5%	<b>100</b>	18.6%	<b>537</b>	100.0%

Source: *Houston Chronicle*, Houston, TX and *New York Times*, New York, NY, September 16 – October 31, 2005

### Entry of Organizations into the Full Response System by Data and Source of Funding





**Table 4**

**Descriptive Statistics, Degree Centrality, Hurricane Rita Response System**

	1	2	3
	Degree	NrmDegree	Share
1 Mean	0.890	0.166	0.002
2 Std Dev	2.063	0.385	0.004
3 Sum	478.00	89.179	1.000
4 Variance	4.254	0.148	0.000
5 SSQ	2710.00	94.328	0.012
6 MCSSQ	2284.52	79.518	0.010
7 Euc Norm	52.058	9.712	0.109
8 Minimum	0.000	0.000	0.000
9 Maximum	23.000	4.291	0.048

Network Centralization = 4.14%

Heterogeneity = 1.19%. Normalized = 1.00%

# Bowtie Architecture for Scalable System 蝴蝶型可剥离系统

INTERNATIONAL LEVEL 国际层次

NATIONAL LEVEL 全国层次

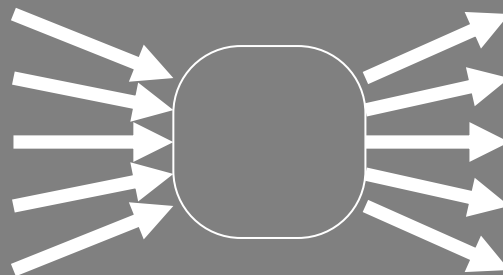
STATE/PROVINCE LEVEL 州/省层次

COUNTY/DISTRICT LEVEL 县/区层次

CITY 市

INFORMATION:

Technical  
Social /  
Organizational  
Physical



ACTION:

Fire  
EMS  
...  
Police  
Hospitals  
Schools

# Computational simulation

## 计算机仿真

- Offers new methods of design, testing for strategies of action in uncertain conditions:
- 提供不确定情形下行动战略的设计与测试方法
  - Identify key parameters that trigger change and indicators for them
  - 识别触发变革的关键参数及其指标

# Computational simulation (cont'd)

## 计算机仿真(续)

- Simulate possible strategies at different rates of time, threat, resources
- 模拟不同时间、威胁程度、资源条件下的可能战略
- Demonstrate findings to decision makers in terms of cost, fragilities of system
- 将有关系统成本、脆弱性等方面的发现提供给决策者
- Identify thresholds at each level of operation that would cause entire system to shift or fail
- 识别每一个层次操作中可能导致整个系统变化或失败的征兆

# Action in disaster contexts... 在灾难情形中行动

- Cognitive structures and processes used for daily operations are inadequate
- 日程运作所用的认知结构和过程是不适当的
- Complexity of disaster environment requires innovative approaches
- 灾难环境的复杂性需要创新性方法



## [Action in disaster contexts...(cont'd) 在灾难情形中行动(续)]

- Cognition, communication, coordination leads to effective mobilization of action
- 认知、沟通、协调产生有效的行动动员
- Control of situation emerges from adaptive reallocation of attention, action
- 事态的控制源自注意力与行动的适应性再分配

# Building resilient communities... 建立回应性社区

- Systems of action that minimize risk and maximize response depend upon:
- 最小化风险最大化反应的行动系统取决于：
  - Carefully developed knowledge bases of region exposed to risk
  - 认真开发受险地区的知识库

## [ Building resilient communities...(cont'd) 建立回应性社区(续) ]

- Models and methods of measurement of risk that capture changing conditions
- 风险测量模型与方法要抓住风险的变化情况
- Continuous feedback, exchange, learning among participating actors in response
- 灾难反应的参与各方要持续反馈、交换信息及学习